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Dielectric properties of 1:1 ternary $Pb_2B^{3+}B^{5+}O_6$ perovskite ceramics sintered from mechanochemically synthesized nanopowders

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Ferroelectric 1:1 ternary perovskite oxides of the $Pb_2B^{3+}B^{5+}O_6$ type, are widely used as a basis or components of various functional materials exhibiting giant dielectric, electrostrictive, pyroelectric, and piezoelectric responses. Properties of these oxides depend crucially on the ordering degree of B^{3+} and B^{5+} cations. While in the highly-ordered state a sharp ferroelectric or antiferroelectric phase transition takes place, in the disordered state a relaxor state is observed, characterized by a diffuse and frequency-dependent maximum of the dielectric permittivity.

Recently we have found out that the use of mechanochemical synthesis enables one to modify substantially relaxor properties of ceramics of the disordered perovskites $Pb_2Fe^{3+}Ta^{5+}O_6$ and $Pb_2MgNb_2O_9$ [1,2]. This effect is believed to be caused by the changes of the degree of the short-range ordering. Such explanation is supported by changes in the magnetic phase transition temperature of $Pb_2Fe^{3+}B^{5+}O_6$ powders (B^{5+} - Nb, Ta) obtained by mechanochemical synthesis [3]. In the present study we investigated the effect of the conditions of the mechanochemical synthesis on the structure and dielectric properties of several $Pb_2B^{3+}B^{5+}O_6$ ceramics (B^{3+} - Sc, In, Yb and B^{5+} - Nb, Ta). These ternary perovskite oxides of the 1:1 type are known to possess a high degree of long-range ordering of B^{3+} and B^{5+} ions when synthesized by a usual solid state route. Mechanochemical synthesis was carried out using high-energy planetary-centrifugal mill AGO-2 with steel balls and jars under a ball acceleration of 40g.

It was found out that high-energy mechanical activation during mechanochemical synthesis stimulates disordering of B^{3+} and B^{5+} cations in ceramics of the $Pb_2B^{3+}B^{5+}O_6$ perovskites studied. Using mechanochemical synthesis disordered modifications of $Pb_2B^{3+}B^{5+}O_6$ (B^{3+} - In, Yb and B^{5+} - Nb, Ta) were obtained for the first time without the use of any additives. In some cases it appeared to be possible to vary within a wide range compositional ordering degree of the B^{3+} and B^{5+} cations and correspondingly both the temperature and diffusion of dielectric permittivity maxima in ceramics by changing the regimes of the mechanochemical synthesis and/or using different starting materials (either oxides or preliminary synthesized $B^{3+}B^{5+}O_4$ precursors). The parameters of the dielectric spectra of the samples exhibiting relaxor-like behaviour also depend on the conditions of the mechanochemical synthesis

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